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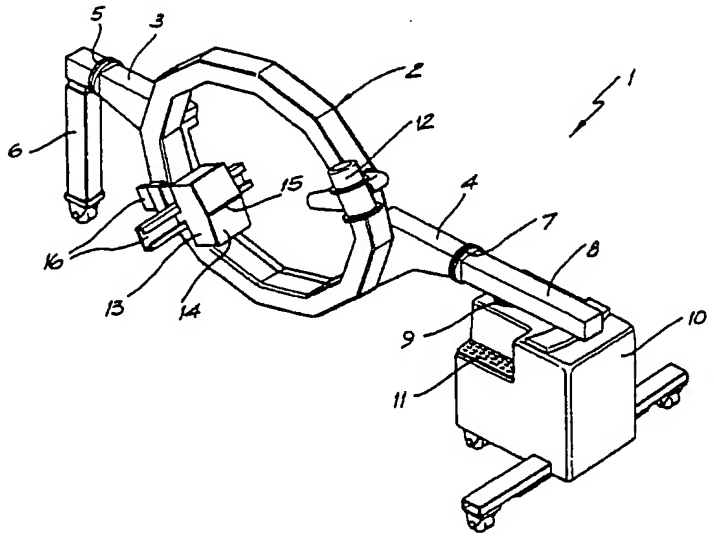

(57) Abstract

A gantry (2) adapted to at least partially surround a subject (17) and having at least one degree of freedom, an X-ray emitter (12) mounted upon the gantry capable of angular movement and/or forward and reverse movement, an X-ray receiver (13) mounted on the gantry essentially opposite the X-ray emitter, wherein the X-ray emitter and X-ray receiver are adapted to traverse about the subject as the X-ray emitter emits X-rays toward the X-ray receiver through the subject and wherein the X-ray receiver comprises a film contained in a carrier, means in or on the carrier to enable the film to be moved in at least a forward or reverse direction, means (16) to enable the film carrier to be moved in at least a clockwise or anti-clockwise direction and/or forward and reverse directions in relation to the X-ray emitter, and an adjustable collimator slot in front of the X-ray emitter.

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SELF CONTAINED APPARATUS FOR SKELETAL RADIOGRAPHIC TOMOGRAPHY

The present invention relates to radiographic devices and more particularly relates to a self contained apparatus for use in skeletal radiographic tomography. It is a well known problem in radiography that some parts of the skeletal frame are very difficult to access using conventional techniques and apparatuses due to interference by other overlying structures in the human body. The problem is particularly manifest in attempting to X-ray the cervical spine using conventional equipment, as the lower regions of the cervical spine and the upper regions of the thoracic spine are obscured by the subject's shoulders.

Spinal fractures very often occur in the cervico-thoracic region. In large patients or those with hunched shoulders, the lower cervico vertebrae may be obscured by the shoulders so this region presents particular problems for accurate imaging.

Whilst the apparatus and methodology of the present invention is suitable for radiographic tomography of most if not all areas of the skeletal frame including regions such as the spine, wrists and ankles, the invention to be described is particularly useful in overcoming the major problems which exist when X-raying the cervico-thoracic spine. Visualisation of the cervical spine by conventional radiography and CT scanning is generally unreliable in demonstrating fractures and/or diseases and the level of radiation required by CT scan to improve visuality is unacceptably high. When diagnosing spinal fractures, particularly in the cervico-thoracic region, it is important that the spine be visualised free from overlying and thus obscuring body structures and it is desirable that this be done with the lowest possible level of radiation.

Among the disadvantages of the existing equipment used in obtaining X-rays of the cervico-thoracic spine are the following:

(a) the image is out of focus or distorted where X-rays are taken of traditionally awkward sites;

(b) the target area is in the shadow of overlying structures resulting in a need to move the patient;

(c) using conventional equipment there are unacceptably high radiation levels, particularly in the case of CAT scans.

Among the known devices is that disclosed in US patent 2798958 by Donald C Hudson entitled "Apparatus for producing radiographs of selected structures within a subject". This patent relates to a device for obtaining radiographic projections of parts located internally of the human body which are difficult to examine. The X-ray apparatus disclosed and the single extra oral film are rotated about the patient with the rate of motion of the film being varied relative to the rate of motion of the X-ray source by a cam mechanism. The equipment described is directed primarily to dental applications. The patent does not, however, disclose the specific combination of features embodied in the present invention to be described below. Moreover, the apparatus described does not have the capability to access areas of the body difficult to X-ray such as the cervico-thoracic region of the spine.

U.S. patent 3045118 by Henry Holliman discloses a panoramic X-ray machine wherein the principal object of the machine is to provide an X-ray for dental radiography. A patient is held stationary while an X-ray source rotates behind a patient and a film holder rotates with the source on a line of sight therewith through the successive teeth being radiographed. The machine disclosed in Holliman does not have a capability to access the more difficult areas of the human body such as the cervico-thoracic spinal region nor does it have the multi degrees of freedom and wide ranging X-ray capability possessed by the apparatus of the present invention.

The present invention seeks to ameliorate the aforesaid problems by providing a self contained apparatus for radiographic tomography of the skeletal frame capable of taking clear radiographs of not only parts of the body which are capable of radiography by conventional means but also clear X-rays of parts which are normally obscured by overlying structures of the body. An advantage of the apparatus of the invention is that a patient under X-ray does not have to be repositioned as the apparatus has the capability of moving through a number of degrees of freedom in order to access the selected site. Furthermore, the patient is not subject to the high level of radiation which would

otherwise be necessary to achieve a similar X-ray result using conventional techniques and apparatus.

In its broadest form the present invention comprises;

a self contained apparatus for use in skeletal radiographic tomography; the apparatus comprising;

a gantry adapted to at least partially surround a subject and having at least one degree of freedom, an X-ray emitter mounted upon the gantry capable of angular movement with or independently on the gantry and/or forward and reverse movement, an X-ray receiver mounted on the gantry essentially opposite the X-ray emitter, wherein the X-ray emitter and X-ray receiver are adapted to traverse about the subject as the X-ray emitter emits X-rays toward the X-ray receiver through the subject and wherein the X-ray receiver comprises a film contained in a carrier,

means in or on the carrier to enable the film to be moved in at least a forward or reverse direction,

means to enable the film carrier to be moved in at least a clockwise or anti clockwise direction and/or forward and reverse directions in relation to the X-ray emitter, and;

an adjustable collimator slot in front of the X-ray emitter.

In another form, the present invention comprises;

a self contained apparatus for use in skeletal radiographic tomography; the apparatus comprising;

a gantry adapted to at least partially surround a subject and having at least one degree of freedom, an X-ray emitter mounted upon the gantry capable of angular movement and/or forward and reverse movement, an X-ray receiver mounted on the gantry essentially opposite the X-ray emitter, wherein the X-ray emitter and X-ray receiver are adapted to traverse about the subject as the X-ray emitter emits X-rays toward the X-ray receiver through the subject and wherein the X-ray receiver comprises a film contained in a carrier,

means in or on the carrier to enable the film to be moved in at least a forward or reverse direction,

means to enable the film carrier to be moved in at least a clockwise or anti clockwise direction and/or forward and reverse directions in relation to the X-ray emitter, and; an adjustable collimator slot in front of the X-ray emitter,
wherein, the apparatus provides detailed and precise continuous and panoramic photographic skeletal images in areas of the body normally obscured by other structures such as in the cervico-thoracic spine.

Preferably, the film is contained in a cassette within the film carrier and the cassette moves inside and along the length of the carrier in conformity with the X-ray emitter as it moves around the subject.

According to the preferred embodiment the gantry includes a circular or horseshoe shaped structure in or through which a patient is placed and which may be mobile and capable of angular movement within the range of 1° to 40° and vertical movement over the distance range (0 to 400 mm). Ideally, the angular movement of the gantry will be closer to $\pm$ 20°. The X-ray emitter preferably is capable of angular movement over the range 1° to 20° and forward and reverse movement so as to be as close as possible to the subject and/or to achieve the desired degree of magnification. The film carrier is synchronised to move with the X-ray emitter and may be moved in a clockwise or anticlockwise direction, laterally or in the forward or reverse directions. The film within the cartridge is moved in a forward or reverse direction so that the film may be placed in the optimum position relative to the subject. The gantry may be pivoted in a vertical plane over the range 1° to 40° but ideally around $\pm$ 30°. The X-ray emitter and receiver traverse about the patient through a predetermined arc of between 1° to 240° made possible by rotation of the gantry. Preferably the collimator slot has an adjustable length but constant width.

The present invention will now be described in more detail according to a preferred but non limiting embodiment and with reference to the accompanying illustrations wherein:

Figure 1: is a schematic isometric view of a radiographic device;

Figure 2: is a schematic plan view of the device of figure 1 showing a typical range through which the gantry might pivot in a horizontal plane;

Figure 3: is a schematic elevational view of the radiographic device showing essentially vertical adjustment of the gantry;

Figure 4: is a schematic end elevational view of the radiographic device;

Figure 5: is a schematic end elevational view showing rotation of the gantry through the vertical plane;

Figure 6: is a schematic cross sectional view taken at VI-VI in figure 3 showing the angular movement of the X-ray emitter and the corresponding movement of the X-ray receiver;

Figure 7: is a schematic detailed view of the X-ray emitter and receiver showing the position of a patient therein and the rotation of the X-ray assembly and the adjustment of the X-ray receiver relative to the subject;

Figure 8: is a schematic illustration depicting the path of an X-ray emitter and receiver about an object; and

Figure 9: shows a side elevational of a human spine.

In the accompanying drawings there is schematically depicted a radiographic apparatus 1 according to a preferred embodiment of the invention. The apparatus 1 is adapted to produce panoramic tomography of a subject and provide radiographs which are similar to conventional views.

Apparatus 1 comprises a gantry 2 affixed to a support beam 3 at one side and another support beam 4 at the other. Support beam 3 is pivotally mounted at hinge point 5 to a support column 6. Support beam 4 is similarly pivotally supported at hinge point 7 to an intermediate beam 8 which is pivotally supported at 9 upon a trolley assembly 10.

Trolley assembly 10 comprises an instrument control panel 11 perhaps communicating with a central processing unit housed within trolley assembly 10.

The gantry 2 has mounted thereto an X-ray emitter 12 and an X-ray receiver 13 located diametrically opposite the emitter 12. Emitter 12 might comprise a collimator to result in emission of collimated X-rays towards the receiver 13.

The receiver 13 preferably comprises an electronic receiving device or alternatively, and as depicted, a housing within which is located a cassette of X-ray film. The receiver housing has mounted thereon a radiation cover 14 having a slot 15 through which X-rays pass to expose film in the cartridge within the housing.

The X-ray receiver 13 is adapted to slide upon tracks 16 both vertically and horizontally for the purpose of adjustment. The horizontal tracks may be curved or straight. Whilst the emitter 12 and receiver 13 are adapted to remain diametrically opposed, they are in unison adapted to rotate about a subject 17 situated upon a support surface 18 (see figure 3) within the gantry 2.

Figure 2 shows a schematic plan view of the device of figure 1 showing a typical range through which the gantry might pivot in a horizontal plane.

As shown in figure 2 the gantry 2 may horizontally pivot throughout a preselected angle. Typically, this angle might be 20° either side from centre.

Figure 3 shows a front elevation view of the gantry of figure 1. This figure shows the vertical movement of the gantry over a range preferably between 0 to 400mm.

Figure 4 shows an end elevation of the gantry of figure 2 taken from the end opposite the trolley assembly 10.

Figure 5 shows the gantry of figure 4 rotated off the vertical demonstrating the degree of freedom of the grantry about the horizontal axis.

Further adjustment is provided in that X-ray emitter 12 may be adjusted throughout a preselected range either side of centre, typically 10° either side as shown in figure 6. Figure 6 shows a section VI - VI taken through the gantry of figure 1.

Further adjustment and repositioning of gantry 2 may take place as depicted in figures 3 and 5. In figure 3 the vertical position of the gantry 2 may be adjusted whereas as shown in figure 5 the vertical plane of the gantry 2 may be adjusted by rotation thereof upon hinges 5 and 7.

In use, the X-ray emitter or tube 12 may be programmed via instrument control panel 11 to move from any set point on the gantry to any other. Figure 8 shows a schematic arrangement showing the path of X-rays about a segment of cervico-thoric spine 20. As shown in figure 8 such movement might be through an arc of say 120° from position A to position B as depicted. At the same time, the X-ray receiver 13 moves throughout a corresponding angle from position C to position D. During this movement, X-rays are emitting from emitter 12 to receiver 13. That is, the X-rays fan across the subject as distinct from conventional views in this sense, but panoramic, continuous depictions of the relevant bone structure for example.

The film cassette located within the housing of receiver 13 will be controlled to advance as fanning of X-ray emitter 12 occurs. The cassette is positioned to capture the information as the radiation transits the subject. The cassette advances along its length as it moves in an arc in uniformity to the X-ray emitter 12. The cassette may be curved or straight or the image could be recorded in electronic form.

The nature of the apparatus described and depicted herein enables views of the whole spine to be produced, both as panoramic representations or views similar to conventional X-rays. A subject (patient) would typically not have to move from the supine, prone to lateral positions if the subject was presented in these ways.

It is further believed that radiation received by the patient could be much lower than that received from equipment employing conventional radiographic techniques.

The apparatus previously described is particularly useful in providing unobscured views of the cervical spine. Figure 9 shows a side elevational view of a typical human vertebrae from which it can be seen that in view of the position of the shoulders, the cervico thoracic region of the spine would normally be obscured when using conventional X-ray equipment to an extent that diagnosis of fractures in this region would be rendered extremely difficult if not impossible.

The apparatus according to the invention is particularly useful in taking X-rays of the Zygapophysial joints in the spine, which joints have proved difficult to X-ray using conventional technology. It is now possible to obtain a panoramic projection over a wide area of the Zygapophysial joints. The apparatus can be used for producing lateral fan projections particularly in the upper vertebrae region at shoulder level. The features of the single unit apparatus described above combine to enable correct angulation of the X-ray equipment relative to the site on the patient to be X-rayed. This is made possible by the combined movement of the gantry and X-ray emitter, film and film cartridge. As each of these elements has multiple degrees of freedom they combine to enable fine adjustment and angulation of the equipment relative to the site on the patient to be X-rayed. These combined actions reduce or eliminate the distortions which otherwise would occur if the X-ray emitter was moved in isolation. If the X-ray tube is angled any more than 15% and no other compensating movement of the receiver is available, the image would be significantly distorted.

The importance of obtaining variable angles for performing X-rays is demonstrated with reference to three basic build types of X-ray subjects.

To categorise patients there are those with a long straight neck, those with the normal curve neck and those with the short neck which is often referred to as a bull neck.

As the curve of the spine is most pronounced at the cervico-thoracic junction, to obtain a quality cervical view, the X-ray emitter must be angled towards the head but if the first

three thoracic vertebrae are under X-ray, the emitter would need to be angled towards the feet.

Thus, all views can be taken without the need to move the patient from the supine position. This is particularly beneficial when the subject under X-ray has serious injuries. Thus, the X-ray beam angle using this equipment can be adjusted to allow for the large variation in spine shape of patients. The X-ray receiver can be moved in and out from the gantry within the focal trough enabling the object to be positioned as close as possible to the receiver thereby providing optimal results.

The X-ray emitter can also be moved toward or away from the patient.

The panoramic apparatus herein described is particularly useful in displaying a radiographic image of the zygapophyseal joints and pedicle independently. This allows visualisation of these areas free from overlying structures, and thus is particular value in spinal injury patients where malalignment may be difficult to see on conventional radiograms.

In general terms, the edge of an object to be X-rayed will be projected on the film only if it is parallel or nearly parallel to the beam in movement of the tube during exposure. It makes no difference whether the edge is vertical to the table top or not. This rule is true for the conventional radiograms as well as tomography. The only differences in tomography are that the edge has to be at the focal plane in order to show on the film and the beam should be tangential to the edge during part of the exposure period.

In radiographic tomography, a cross section is only obtained if the boundary planes of the object are momentarily struck tangentially by the projecting rays at the level of the focal plane.

In order to describe a use of the apparatus according to a preferred embodiment of the present invention, the horizontal axis across the gantry will be referred to as the X axis and the vertical axis across the gantry will be referred to as the Y axis.

To obtain radiographic images of the zygapophyseal joints and pedicles, the patient is placed on a spinal table in the supine position, with the area of the spine to be X-rayed in the center of the gantry. The Y axis is in the mid plane of the patient and the X axis bisecting the spine at right angles.

The X-ray tube is positioned posteriorly to the patient and the gantry is raised so the focal trough falls within the area of interest.

The X-ray tube is angled to the head so the primary beam runs parallel, to the zygapophyseal joints. As this angle will vary from patient to patient, the gantry may need to be angled on the X axis with the lower end of the Y axis to the feet.

The film cartridge will need to be adjusted so it is in the same plane as the X-ray beam and as close to the object as possible. The arc within which the X-ray tube will move is at least 40 each side of the vertical Y axis. As the X-ray tube moves in this set arc the film cartridge will move in uniformity.

Opposite to the X-ray tube and on the anterior side of the patient in front of the film is a radiation protection cover with a thin window to allow the primary X-ray beam to enter and expose the film. The film cassette within the cartridge advances along its length as it moves in uniformity to the X-ray tube moving around the object in the given arc.

Radiographic images of the body of the spine can be obtained using this panoramic device. The body surface and therefore any slight depression of this area can be seen. The uncovertabral joints which are difficult to display on conventional radiograms can be seen and well demonstrated by use of the above method.

To obtain these images, the patient is placed on the spinal table in the supine position, with the area of the spine to be X-rayed in the center of the gantry, the Y axis is in the mid plane of the patient and the X axis bisecting the spine at right angles.

The X-ray tube is positioned anteriorly to the patient and the gantry is lowered so the focal trough falls within the area of interest.

The X-ray tube may need to be angled either to the head or feet depending on how the body of the spine is presented. The primary beam runs parallel to the body of the spine surface. The film cartridge will need to be adjusted so it is in the same plane as the X-ray beam and moved as close to the object as possible.

The arc within which the X-ray tube will move is at least 10 each side of the vertical Y axis. As the X-ray tube moves in this set arc the film cartridge will move in uniformity.

Opposite to the X-ray tube and on the posterior side of the patient in front of the film is a radiation protection cover with a thin window to allow the primary X-ray beam to enter and expose the film. The film cassette advances along its length as it moves in uniformity to the X-ray tube moving around the object in the given arc.

The inherent flexibility of the apparatus now enables clear panoramic X-rays to be taken of sites such as but not limited to ankles, wrists and the cervico-thoracic region of the spine which, with existing equipment, are difficult to X-ray clearly and rendering precise diagnosis difficult.

It should be appreciated that modifications and alterations obvious to those skilled in the art are not to be considered as beyond the scope of the present invention. For example, whilst the unit depicted and described herein is a mobile unit, a larger, static machine with relatively high output might be constructed on similar design principles. Also, several movements of the apparatus described could be replicated by using a fully articulated subject (patient) table.

THE CLAIMS:

1. A self contained apparatus for use in skeletal radiographic tomography; the apparatus comprising;
a gantry adapted to at least partially surround a subject and having at least one degree of freedom, an X-ray emitter mounted upon the gantry capable of angular movement and/or forward and reverse movement, an X-ray receiver mounted on the gantry essentially opposite the X-ray emitter, wherein the X-ray emitter and X-ray receiver are adapted to traverse about the subject as the X-ray emitter emits X-rays toward the X-ray receiver through the subject and wherein the X-ray receiver comprises a film contained in a carrier,
means in or on the carrier to enable the film to be moved in at least a forward or reverse direction,
means to enable the film carrier to be moved in at least a clockwise or anti clockwise direction and/or forward and reverse directions in relation to the X-ray emitter, and;
an adjustable collimator slot in front of the X-ray emitter.

2. A self contained apparatus for use in skeletal radiographic tomography; the apparatus comprising;
a gantry adapted to at least partially surround a subject and having at least one degree of freedom, an X-ray emitter mounted upon the gantry capable of angular movement and/or forward and reverse movement, an X-ray receiver mounted on the gantry essentially opposite the X-ray emitter, wherein the X-ray emitter and X-ray receiver are adapted to traverse about the subject as the X-ray emitter emits X-rays toward the X-ray receiver through the subject and wherein the X-ray receiver comprises a film contained in a carrier,
means in or on the carrier to enable the film to be moved at least in a forward or reverse direction,
means to enable the film carrier to be moved in at least a clockwise or anti clockwise direction and/or forward and reverse directions in relation to the X-ray emitter, and; an adjustable collimator slot in front of the X-ray emitter,

wherein, the apparatus provides detailed and precise continuous and panoramic photographic skeletal images in areas of the body normally obscured by other structures such as in the cervico-thoracic spine.

3. An apparatus according to claims 1 or 2 wherein said means in or on the film carrier comprises a cassette within the film carrier wherein the cassette moves along the length of the carrier said movement of the film carrier being synchronised with the X-ray emitter as it moves around the subject.

4. An apparatus according to claim 3 wherein said means to enable the carrier to be moved at least in either a clockwise or anti clockwise direction comprises a guide member including at least one set of tracks along which said carrier travels.

5. An apparatus according to claim 4 wherein forward and reverse movement of the film alone or in combination with clockwise or anticlockwise movement of the cartridge allows 360° X-ray access to the cervico-thoracic spine.

6. An apparatus according to claim 5 wherein the X-ray emitter is capable of a range of angular movement between 1° and 20° and forward and reverse movement to an extent which allows the X-ray emitter to be as close as possible to the subject.

7. An apparatus according to claim 6 wherein the collimator slot has adjustable length but constant width.

8. An apparatus according to claim 7 wherein the X-ray emitter and receiver traverse through an arc of 1° to 240° as a result of rotation of the gantry.

9. An apparatus according to claim 8 wherein the gantry pivots in a plane within the range 1° to 40° and undergoes vertical movement over the range 0 to 400mm.

10. An apparatus according to claim 9 wherein the gantry is pivotable in a vertical plane over the range 1° to 40°.

11. An apparatus according to claim 10 wherein the X-ray receiver is diametrically opposite the X-ray emitter.

12. An apparatus according to claim 11 wherein the receiver housing has mounted thereon a radiation cover having a slot through which X-rays pass to expose the film in the cartridge within the housing.

13. An apparatus according to claim 12 wherein the receiver slides along vertical and/or horizontal tracks thereby enabling adjustment of the orientation of the film relative to a patient.

14 A film carrier including a film cassette for use with an apparatus for panoramic radiographic tomography as hereinbefore described said carrier comprising a housing, guide means associated therewith to enable at least clockwise or anticlockwise rotation of the carrier, and means in or on the housing to enable the carrier to advance and retract or to move laterally relative to the direction of the X-ray emitter.

15. A film carrier according to claim 14 wherein the film cassette moves along the length of the carrier.

16. A film carrier according to claim 15 wherein the film cassette advances and retracts within the film carrier.

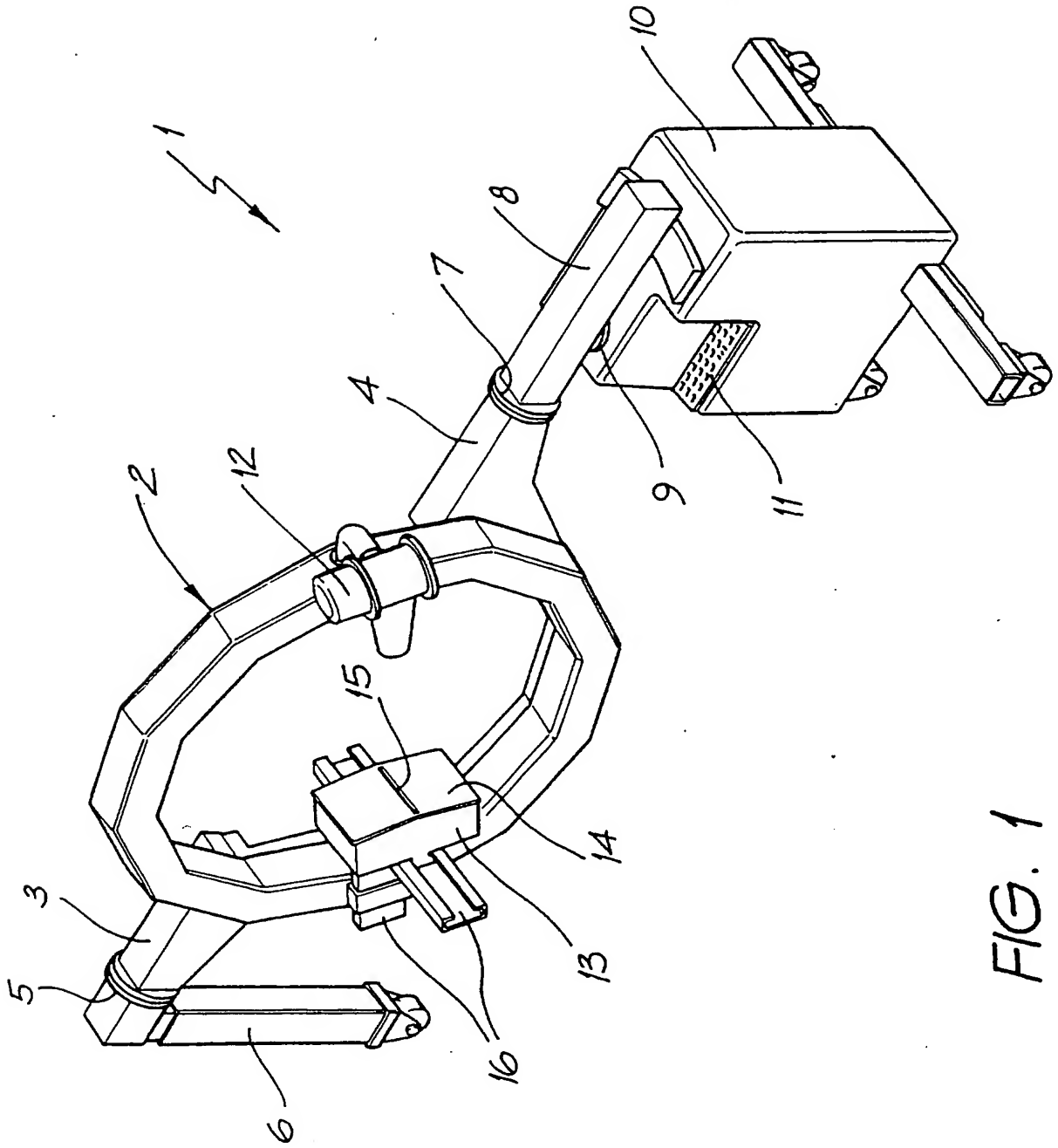

FIG. 1

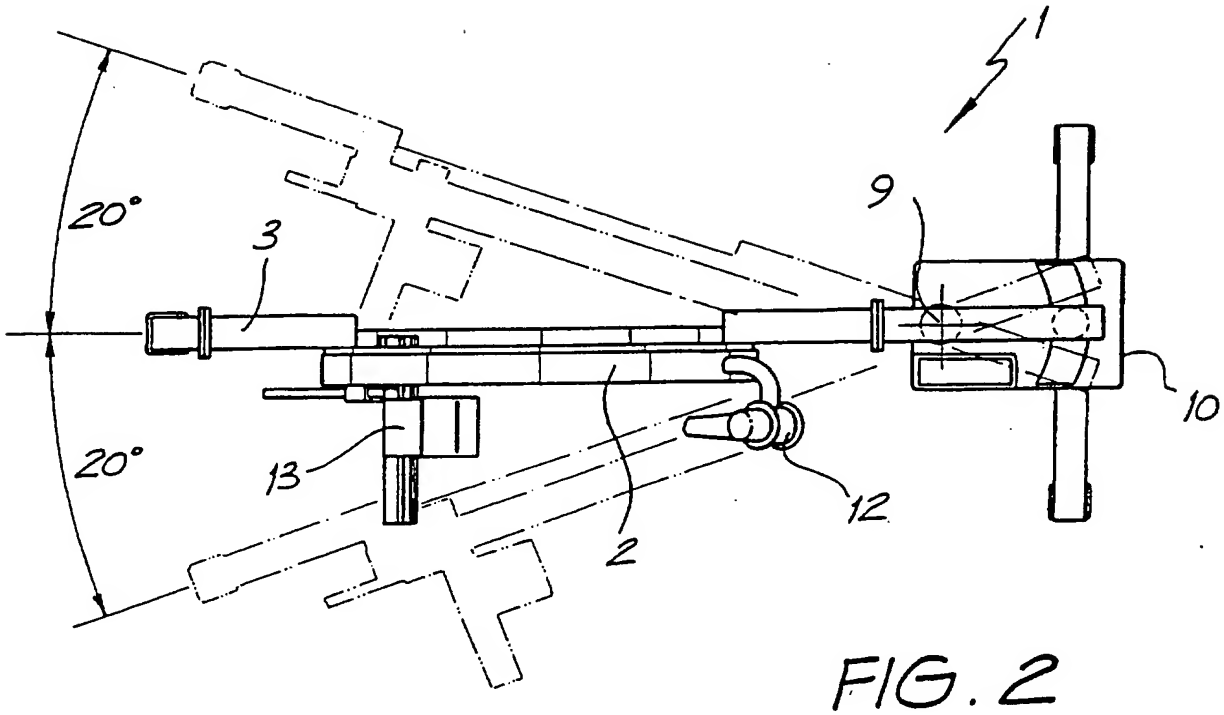

FIG. 2

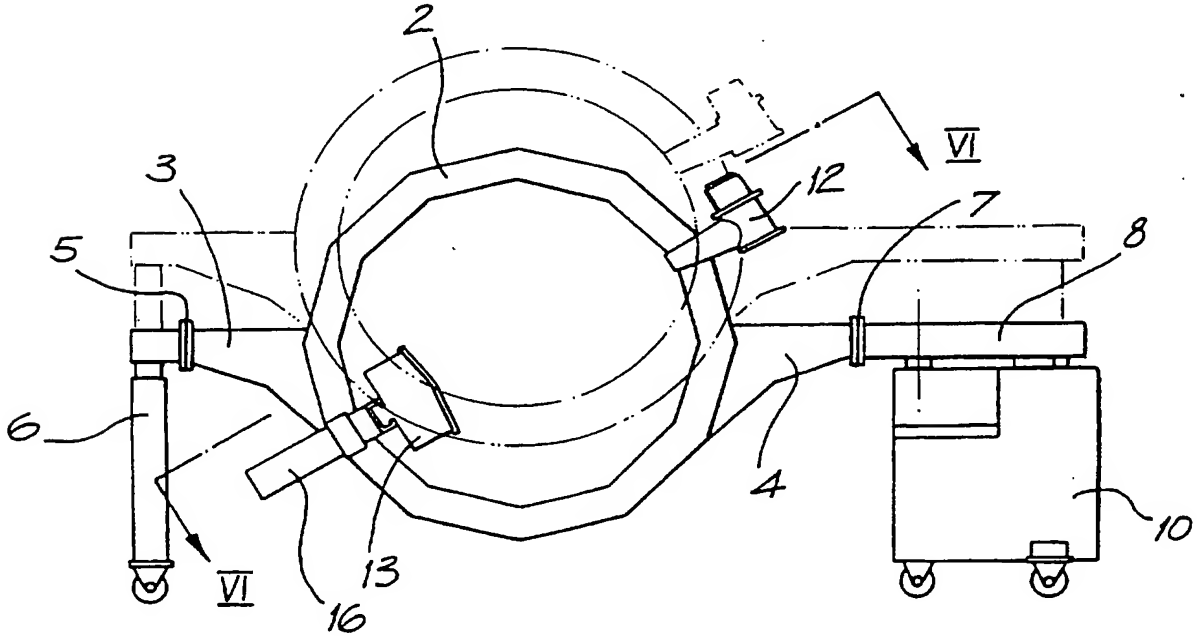

FIG. 3

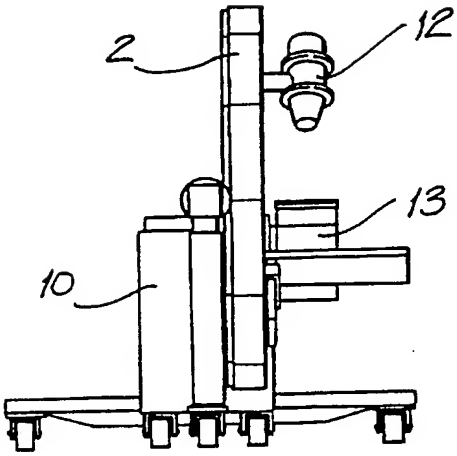

FIG. 4

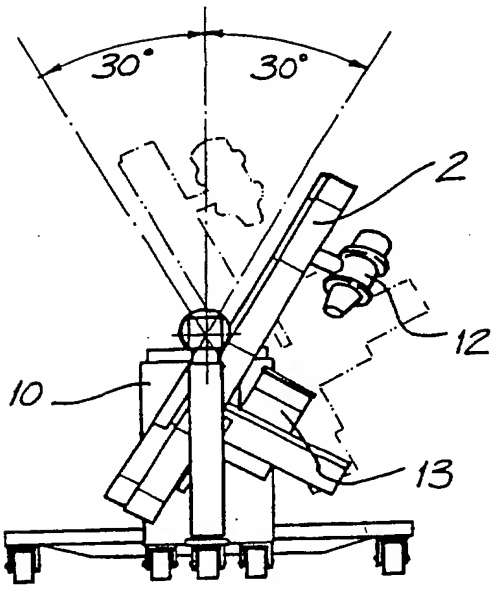

FIG. 5

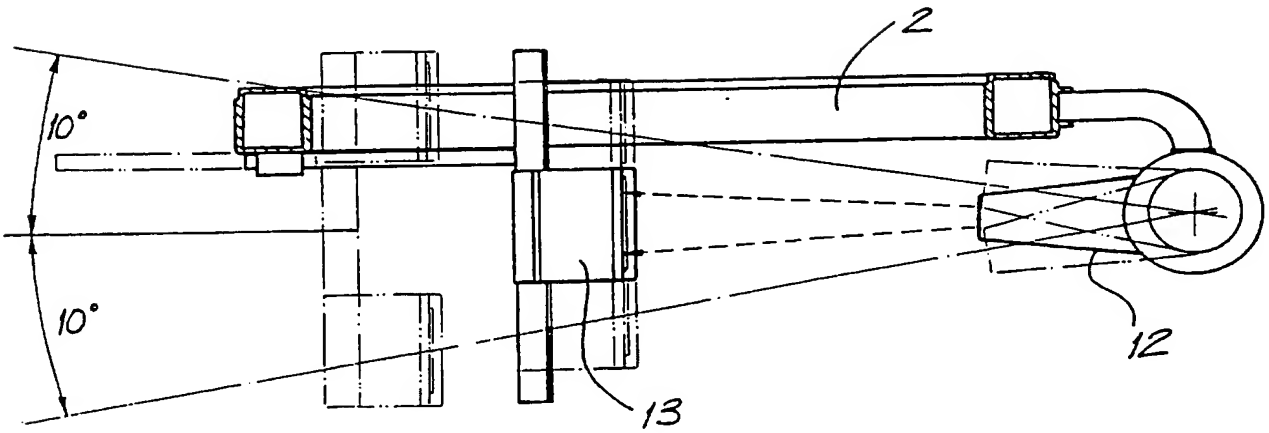

FIG. 6

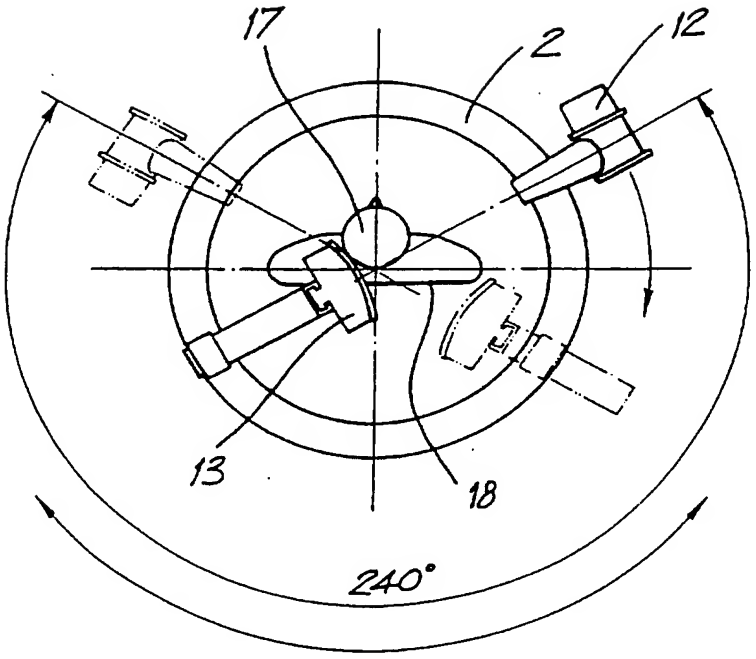

FIG. 7

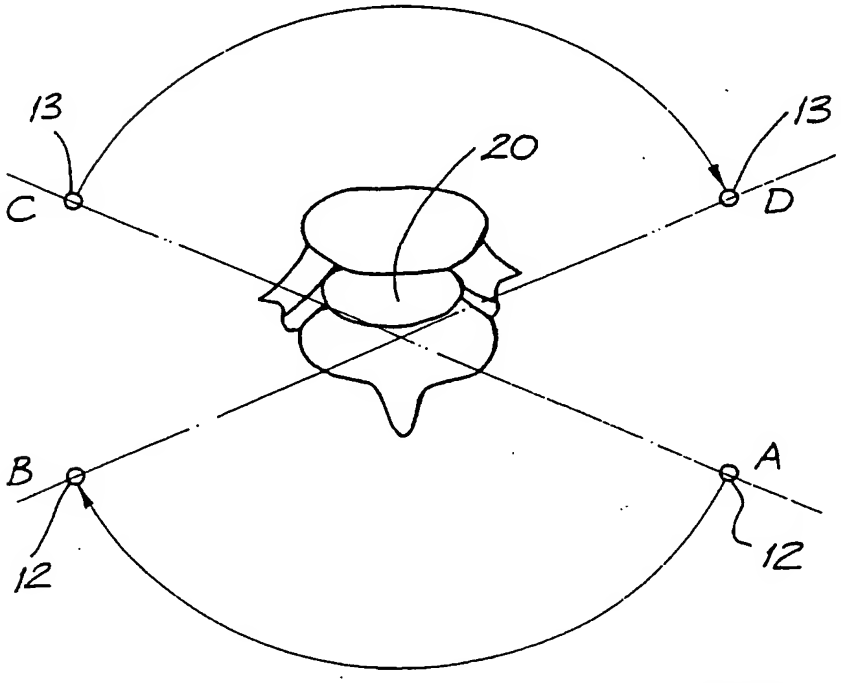

FIG. 8

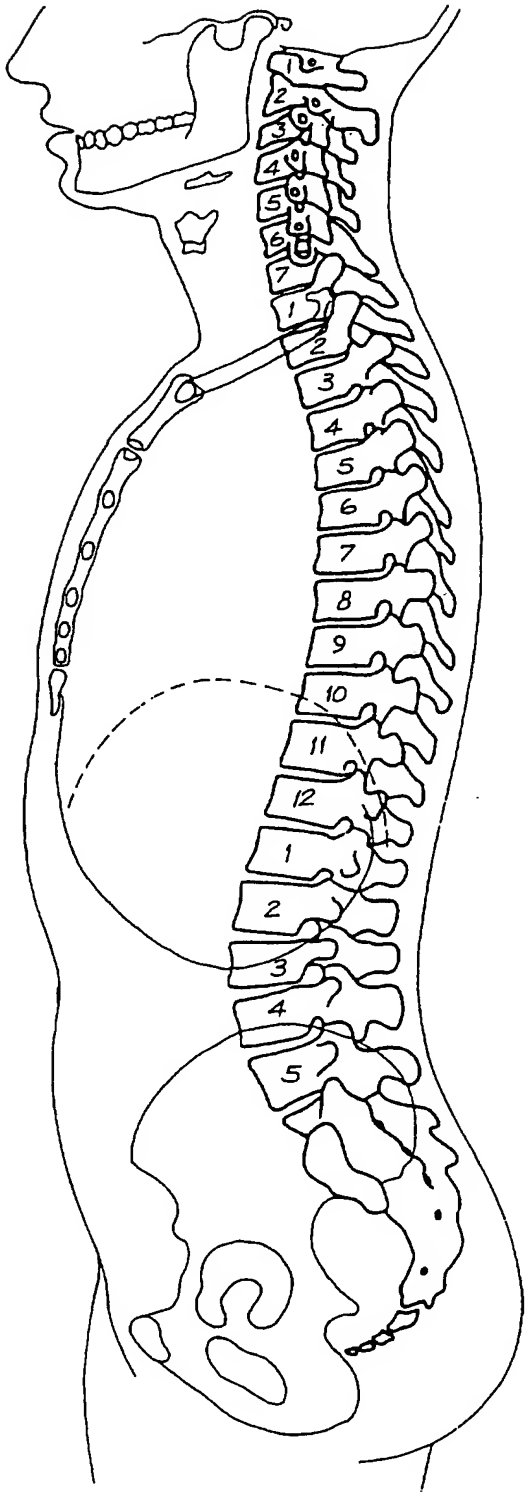

FIG. 9

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 95/00556

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: A61B 6/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC : A61B 6/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU : IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5014293 A (BOYD et al.) 7 May 1991 See figures 1 and 2.	1 to 13
Y	US 4935949 A (FUJITA et al.) 19 June 1990 See figures.	1 to 13
X Y	US 4847881 A (HEUBECK) 11 July 1989 See figures 1 and 2, column 2 line 20.	1 to 16 1 to 13

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 February 1996	8 FEB 1996
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (06) 285 3929	Authorized officer P. WEST Telephone No.: (06) 283 2108

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INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 95/00556

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4741015 A (CHARRIER) 26 April 1988 See figure 1.	1 to 13
X Y	US 4589122 A (NIEMINEN) 13 May 1986 See figure 2.	14 to 16 1 to 13
X Y	US 2798958 A (HUDSON et al.) 9 July 1957 See figures 1 and 5.	1 to 16 1 to 13
Y	DE 4312640 A (K.K. MORITA SEISAKUSHO) 4 November 1993 See figures 8 and 13, items 3a-3c	14 to 16
A	DE 3321057 A (RÖDER) 13 December 1984 See figure 1.	1 to 13
A	US 4870673 A (ADLER et al.) 26 September 1989	
A	US 3045118 A (HOLLMAN et al.) 17 July 1962	

INTERNATIONAL SEARCH REPORT
Information on patent family members

International Application No.
PCT/AU 95/00556

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	5014293						
US	4935949	EP	297138	JP	62179434	WO	8704609
US	4870673	EP	262522				
US	4847881	EP	229971				
US	4741015						
US	4589122	DE	3434369	FI	833754		
US	3045118						
US	2798958						
DE	4312640	FI	931947	JP	6000181	US	5355398
DE	3321057						

END OF ANNEX